DESCRIPTION

COMPRESSOR AND SUCTION VALVE STRUCTURE

Technical Field

The present invention relates to a compressor that compresses coolant gas in a refrigeration cycle of a vehicle air conditioner or the like, and relates, more particularly to a valve structure of the compressor.

Background Art

A compressor disclosed in Japanese Patent Publication No. 3326909 (first related art) is proposed for the compressor to be used to compress coolant gas. According to the compressor of the first related art, the compressor comprises a cylinder block in which cylinder bores are formed, a crank chamber provided at the front of the cylinder block, and a suction chamber and a discharge chamber provided at the front end of the cylinder block, and a valve provided between the cylinder bore, the suction chamber, and the discharge chamber. The valve further includes a valve plate having a suction hole that communicates between each cylinder bore and the suction chamber, and a discharge hole that communicates between each cylinder bore and the discharge chamber, and also includes so-called a reed valve type suction valve which is provided in the cylinder bore of the valve plate, and can open and close the suction hole.

A piston which is accommodated in each cylinder bore is reciprocated by utilizing the rotation of a drive shaft axially supported within the crank chamber, thereby compressing the coolant taken into each cylinder bore from the suction chamber through the suction hole, and sending out the compressed coolant into the

discharge chamber from the discharge hole.

When the operation of the compressor is started in a suspension state, because the coolant volume remaining each of the cylinder bores are different, the coolant pressure fluctuates in the refrigeration cycle immediately after the starting. Therefore, a problem arises such that a suction pressure pulsation occurs and generates noise from an evaporator of the refrigeration cycle until when the operation is stabilized.

In order to solve the above problem, the compressor proposed in the first related art mentioned above decreases the occurrence of noise by providing a pressure reduction path communicated with the suction chamber by forming a rough surface an a valve seat that is in contact with the suction valve, in order to quickly lower the pressure of the coolant within the cylinder bore in the suspension state of the compressor.

Meanwhile, Japanese Patent Application Laid-open No. 52-147302 (second related art) proposes a valve structure of a compressor, according to the second related art, a pressure reduction path, which is comprised of a thin plate being disposed between the suction valve and the valve seat, or comprised of a groove being provided around the suction hole, is provided for discharging the coolant from the cylinder bore into the suction chamber for reducing the pressure.

Disclosure of Invention

However, when providing the rough surface on the valve seat forms the pressure reduction path, the size of the pressure reduction path formed between the suction valve and the valve seat is not constant. Therefore, the quantity of the coolant being discharged from a plurality of the suction valve is not uniform, so that there is still a possibility of generating a suction pressure pulsation.

Furthermore, when the groove is provided around the suction hole as described in the second related art, a mechanical processing to provide the groove is carried out in high precision on the valve plate. Therefore, it is troublesome to form the pressure reduction path, which results in high manufacturing cost.

When the thin plate is used, a simple plate has a risk of generating collision noise when the suction valve collides against the thin plate.

The object of present invention is to provide a compressor that can be processed easily and that has clearances (pressure reduction paths) being formed in a uniform size.

In order to achieve the above object, the compressor disclosed in the present invention includes: a cylinder block which has a cylinder bore to accommodate a piston; a crank chamber which is provided at one end of the cylinder block; a suction chamber and a discharge chamber that are provided at the other end of the cylinder block; a valve that is provided between the cylinder bore and the suction chamber and between the cylinder bore and the discharge chamber; a valve plate provided with the valve and having a suction hole to communicate between the cylinder bore and the suction chamber and a discharge hole to communicate between the cylinder bore and the discharge chamber; a suction valve provided with the valve and assemble to the side of the cylinder bore of the valve plate, and the suction valve is comprised of a flexible plate to be able to open and close the suction hole; a drive shaft that is rotatably and axially supported within the crank chamber to reciprocally actuate the piston; and a valve structure in which the suction valve is formed with a suction valve main body, and an opposing part that is integrally formed on the suction valve main body, and faces the suction hole and a valve seat at the opening edge of the suction hole so as to be able to open and close the suction hole, and

clearance forming means, which forms a predetermined clearance between the opposing part and the valve seat by isolating the opposing part from the valve seat by a predetermined distance, is formed on at least one of the valve plate and the suction valve.

Brief Description of Drawings

Fig. 1 is a cross-sectional view of a valve structure of a compressor showing a relationship between a valve seat of a suction hole and an opposing part, according to a first embodiment of the present invention.

Fig. 2 is a cross-sectional view of a compressor according to the present invention.

Fig.3A shows a top plan view of the valve plate, and Fig. 3B shows a cross-sectional view of the valve plate cut along a line IIIB-IIIB in Fig. 3A.

Fig. 4A shows a top plan view showing a front surface of the suction valve, Fig. 4B shows a top plan view showing a back surface of the suction valve onto which a coating layer is formed, and Fig. 4C shows a cross-sectional view of the suction valve cut along a line IVC-IVC in Fig. 4B.

Fig. 5A shows a top plan view of the valve plate, Fig. 5B shows a cross-sectional view of the valve plate cut along a line VB-VB in Fig. 5A, and Fig. 5C shows a cross-sectional view of the valve plate showing a relationship with a opposing part.

Fig. 6 is a partly cross-sectional view of a suction valve and a valve plate according to a third embodiment of the present invention.

Fig. 7 is a partly cross-sectional view of a suction valve and a valve plate according to a fourth embodiment of the present invention.

Fig. 8 is a partly cross-sectional view of a suction valve and a valve plate

according to a fifth embodiment of the present invention.

Figs. 9A and 9B show a sixth embodiment of the present invention, Fig. 9A shows a partly cross-sectional view of the suction valve and the valve plate, and Fig. 9B shows a partly enlarged view of Fig. 9A.

Fig. 10 is a partly cross-sectional view of a suction valve and a valve plate according to a seventh embodiment of the present invention.

Figs. 11A and 11B show an eighth embodiment of the present invention, Fig. 11A is a partly cross-sectional view of the suction valve and the valve plate, and Fig. 11B is a partly enlarged view of Fig. 11A.

Best Mode for Carrying Out the Invention

Embodiments of the present invention will be explained below with reference to the drawings.

As shown in Fig. 2, a compressor 1 to which the present invention is applied is what is called a variable displacement swash plate variable displacement compressor, which includes an approximately cylindrical cylinder block 3 having a plurality of cylinder bores 2, a front housing 5 connected to the front end surface of the cylinder block 3 and forming a crank chamber 4 between the cylinder block 3 and the front housing 5, and a rear housing 9 connected to the rear end of the cylinder block 3 via a valve 6 and forming a suction chamber 7 and a discharge chamber 8. The cylinder block 3, the front housing 5, and the rear housing 9 are fastened and fixed with through bolts 11 penetrated into through bolts penetration holes (through holes) 10 provided on the cylinder block 3.

The valve 6 further includes a valve plate 12, a suction valve 13 provided at the cylinder bore 2 side of the valve plate 12, a discharge valve plate 14 provided at the rear housing 9 side, and a retainer 15 that controls the opening and closing of the

discharge valve plate 14. The suction valve 13, the discharge valve plate 14, the retainer 15, and the valve plate 12 are sandwiched in a state that they are integrally fastened and fixed with a rivet 16, between the cylinder block 3 and the rear housing 9. A gasket 17 is disposed between the valve plate 12 and the rear housing 9, and isolates between the suction chamber 7 and the discharge chamber 8 and between the suction chamber 7 and the outside respectively. An O-ring 18 is disposed on the peripheral surface of the valve plate 12, and prevents the coolant from leaking to the outside of the compressor 1.

As shown in Fig. 3A, the valve plate 12 is formed with suction holes 20 at six positions at a uniform angle along the peripheral direction corresponding to the cylinder bores 2 on the outer periphery of a disk-shaped valve plate main body 19 wherein each hole 20 connects the cylinder bore 2 and the suction chamber 7, and discharge holes 21 provided at six positions at the inside of these suction holes 20, that is, at the center side along the peripheral direction. A groove 22 is formed around the suction hole 20 to surround the suction hole 20 as shown in Fig. 3B. A space between the groove 22 and the suction hole 20 is a valve seat 23 onto which the suction valve 13 is assembled. The rivet is penetrates through a hole 24 provided at the center of the valve plate 12.

The suction valve 13 provided in the cylinder bore 2 of the valve plate 12 is comprised of a flexible thin disk as shown in Figs. 4A to 4C, and is formed with a suction valve main body 25, an opposing part 26 that is integrally formed on the suction valve main body 25, and faces the suction hole 20 and the valve seat 23 at the opening edge of the suction hole 20 to be able to open and close the suction hole 20, and an arm valve (an arm portion) 48 that is provided on the suction valve main body 25.

Further, a coating layer 29 as clearance forming means 28 to form a predetermined clearance 27 (refer to Fig. 1) between the opposing part 26 and the valve seat 23 by isolating the opposing part 26 from the valve seat 23 by a predetermined distance L1 (refer to Fig. 1) is formed on one surface of the suction valve main body 25 (at the valve plate 12 side) (at the position indicated by shaded areas in Fig. 4B). As shown in Fig. 4C, the thickness of the coating layer 29 is L2, and the opposing part 26 is isolated from the suction hole 20 and the valve seat 23 at the opening edge of the suction hole 20 by the predetermined distance L1. The coating layer 29 is formed with a fluorine coating film, such as Teflon (registered trademark).

A drive shaft 30 is disposed at the center of the cylinder block 3 and the front housing 5. One end of the drive shaft 30 is supported by a shaft supporting hole 31 of the front housing 5 via a bearing 32, and the other end of the drive shaft 30 is supported by a shaft supporting hole 33 of the cylinder block 3 via a bearing 34.

Further, a drive plate 40a fixed to the drive shaft 30, a journal 37 which is pivotally linked to a pin 36 that is provided on a sleeve 35 slidably engaged with the drive shaft 30, and a swash plate 39 fixed to a boss 38 of the journal 37 are provided within the crank chamber 4 of the front housing 5.

A pin 50 being protruded from a hinge arm 37a of the journal 37 is slidably engaged with an elongate hole 49 provided with a drive plate 40, and therefore, the range of movement of the swash plate 39 is restricted by the pin 50 and the elongate hole 49. A piston 41 accommodated in each cylinder bore 2 is linked with the swash plate 39 via a pair of shoes 42 that tightly holds the swash plate 39, and moves reciprocally using the rotational movement of the drive shaft 30 as motive

force. By the reciprocal movement of the piston 41, the coolant is guided from the suction chamber 7 to the suction hole 20 of the valve plate 12, and into the cylinder bore 2. After the coolant is compressed, the coolant is guided from the cylinder bore 2 to the discharge hole 21 of the valve plate 12, and thereafter guided to the discharge chamber 8. Then, the coolant is discharged from the discharge chamber 8.

Further, a pressure control mechanism is provided which includes a coolant gas bleed path (not shown) that always communicates between the crank chamber 4 and the suction chamber 7 to make the coolant discharge quantity variable, a coolant gas supply path (not shown) that communicates between the crank chamber 4 and the discharge chamber 8, and a pressure controller 43 that opens and closes the coolant gas supply path.

In the valve structure of the compressor 1 according to the first embodiment, when the compressor 1 is started in a suspension state, that is, when the swash plate 39 rotates by the rotational drive force of the drive shaft 30 to cause the plurality of pistons 41 to move reciprocally in the cylinder bore 2, the coolant is absorbed from the suction hole 20 when the pistons 41 move to the front housing 5 side within the cylinder bore 2, and the coolant remaining in the suspension state is compressed and is discharged from the discharge hole 21 into the discharge chamber 8 when the pistons 41 move to the rear housing 9 side within the cylinder bore 2.

According to the valve structure in the present invention, since the predetermined clearance 27 is provided between the valve seat 23 of the suction hole 20 and the opposing part 26 by providing the coating layer 29, the coolant is absorbed into the cylinder bore 2 simultaneously with the starting of the compressor, a difference of the pressure in the suction chamber 7 and the pressure in the cylinder

bore 2 can be restricted, thereby decreasing the suction pressure pulsation, when the move of the piston 41 absorbs the coolant into the cylinder bore 2. Consequently, noise due to the variation in the pressure of the coolant within the refrigeration cycle can be decreased. When the move of the piston 41 compresses the coolant within the cylinder bore 2, the opposing part 26 of the suction valve 13 is quickly brought into contact with the valve seat 23 to close the suction hole 20. Based on this, the coolant absorbed in the cylinder bore 2 is compressed within the cylinder bore 2. At a pressure above a predetermined level, the discharge valve plate 14 sags, and discharges the compressed coolant from the discharge hole 21 to the discharge chamber 8.

Further, in the first embodiment, as the clearance 27 is formed by providing the coating layer 29, it is not troublesome to manufacture the valve plate 12, requiring no mechanical processing. Therefore, the clearances 27 can be formed easily, and the manufacturing cost can be decreased.

Further, according to the first embodiment, as the valve plate 12 is not mechanically processed, neither internal stress nor distortion or the like occurs in the valve plate 12 due to mechanical processing.

While the example of forming the coating layer 29 in the suction valve main body 25 of the suction valve 13 is explained in the first embodiment, the coating layer 29 may be formed in the main body 19 of the valve plate 12. Alternatively, the coating layer 29 may be formed in both the valve plate 12 and the suction valve main body 25. In this case, by setting the opposing part 26 apart with the predetermined distance L1 from the suction hole 20 and the valve seat 23, uniform clearances can be formed easily.

A second embodiment shown in Figs. 5A to 5C will be explained next.

As shown in Figs. 5 A to 5C, in the valve structure of the compressor according to the second embodiment, a convex portion 44 is provided at a predetermined peripheral position of the valve seat 23 of the suction hole 20 of the valve plate 12 as the clearance forming means 28. Based on the convex portion 44 (the clearance forming means 28), the opposing part 26 is separated by a predetermined distance from the opening and the opening edge of the suction hole 20.

In the second embodiment, a predetermined clearance 45 is provided between the valve seat 23 of the suction hole 20 and the opposing part 26 by the convex portion 44 in a similar manner to that in the first embodiment. Therefore, the coolant is absorbed into the cylinder bore 2 simultaneously with the starting of the compressor, a difference of the pressure in the suction chamber 7 and the pressure in the cylinder bore 2 can be restricted, thereby decreasing the suction pressure pulsation. Consequently, noise can be decreased.

Further, according to the second embodiment, the processing method of forming the convex portion 44 at a predetermined peripheral position of the valve seat 23 is easier than the conventional processing method of forming a groove on the valve plate 12. Further, manufacturing cost can also be decreased.

A third embodiment shown in Fig. 6 will be explained next.

As shown in Fig. 6, in the valve structure of the compressor according to the third embodiment, a sheet member 60 is disposed between the valve plate main body 19 of the valve plate 12 and the suction valve main body 25 of the suction valve 13, and the sheet member 60 performs as the clearance forming means 28. This sheet member 60 may be formed with an elastic member such as rubber.

Other structures of this embodiment are similar to those in the first

embodiment, and therefore, their explanation will be omitted.

In the third embodiment, a clearance 27a having the predetermined size L1 is formed by the elastic sheet member 60, the occurrence of noise due to the suction pressure pulsation can be prevented.

Further, in the third embodiment, the valve plate 12 of the suction valve main body 25 collides against the sheet member 60 and the sheet member 60 absorbs the collision force, when the suction valve 13 is opened or closed. Therefore, noise due to the collision of the suction valve 13 can also be decreased.

A fourth embodiment shown in Fig. 7 will be explained next.

As shown in Fig. 7, in the valve structure of the compressor according to the fourth embodiment, a concave portion 61 of the suction valve 13 performs as the clearance forming means 28, wherein the opposing part 26 thinner than the suction valve main body 25. The concave portion 61 is formed by pressing or cutting.

Other structures of this embodiment are similar to those in the first embodiment, and therefore, their explanation will be omitted.

In the fourth embodiment, a clearance 27b having the predetermined size L1 is formed by the concave portion 61, the occurrence of noise due to the suction pressure pulsation can be prevented.

A fifth embodiment shown in Fig. 8 will be explained next.

As shown in Fig. 8, in the valve structure of the compressor according to the fifth embodiment, the clearance forming means 28 is comprised of a concave portion 62 that is provided by having a range where at the edge of the suction hole 20 of the valve plate 12 including the valve seat 23 and is formed thinner than the other valve plate main body 19. The concave portion 62 is formed by pressing or cutting.

Other structures of this embodiment are similar to those in the first embodiment, and therefore, their explanation will be omitted.

In the fifth embodiment, as the concave portion 62 forms a predetermined clearance 27c, the occurrence of noise due to the suction pressure pulsation can be prevented.

A sixth embodiment shown in Figs. 9A and 9B will be explained next.

As shown in Figs. 9A and 9B, in comparing the sixth embodiment with the fifth embodiment, the sixth embodiment is different only in that a portion 63a of an outer edge step of the groove 22 is chamfered or rounded. Other structures are similar to those in the fifth embodiment, and therefore, their explanation will be omitted.

In the sixth embodiment, the stress of the suction valve at the opening and closing times of the suction hole 20 is mitigated, and durability of the suction valve improves.

A seventh embodiment shown in Fig. 10 will be explained next.

As shown in Fig. 10, in comparing the seventh embodiment with the fifth embodiment, the seventh embodiment is different only in that a distance S between the outer edge surface of the groove 22 and the valve seat 23 is set large.

More particularly, as shown in Fig.10, the width of the groove 22 (left side in Fig.10) is lager than the width of the other side of the groove 22 (right side in Fig.10).

Other structures of this embodiment are similar to those in the fifth embodiment, and therefore, their explanation will be omitted.

In the seventh embodiment, the stress of the suction valve at the opening and closing times of the suction hole 20 is mitigated, and durability of the suction

valve improves.

An eighth embodiment shown in Figs. 11A and 11B will be explained next.

As shown in Figs. 11A and 11B, in comparing the eighth embodiment with the sixth embodiment, the eighth embodiment is different in that a portion 63b of the upper surface of the valve seat 12 is chamfered or rounded.

In the eighth embodiment, the chamfered or rounded portion 63b mitigates the internal stress generated in the valve seat 23 at the time of forming the concavity 62. Therefore, the occurrence of a distortion or the like in the valve plate 12 can be prevented as much as possible.

Industrial Applicability

According to the present invention, the clearance forming means separates the suction hole and the suction seat at the opening edge of the suction hole from the opposing part at a predetermined distance. Therefore, the clearance having a uniform size can be formed. As the coolant can be quickly absorbed into the cylinder bore through the clearance immediately after the starting, the occurrence of noise due to the suction pressure pulsation can be prevented.

Further, according to the present invention, in addition to the above work effect, the processing is facilitated only by providing the coating layer in at least one of the valve plate main body and the valve main body. This can decrease the manufacturing cost.

Further, according to the present invention, as only the convex portion is provided at a predetermined position of the valve seat of the suction hole of the valve plate, the processing is facilitated and when only the height of a projection is managed at the time of forming the convex portion, the clearances can be formed in a uniform size.

Further, according to the present invention, in addition to the above work effect, the valve plate of the suction valve collides against the sheet member when the suction valve is opened or closed, and the sheet member absorbs the force of the collision, thereby, noise due to the collision of the suction valve can be decreased.

Further, according to the present invention, in addition to the above work effect of the invention, as the suction valve makes it easy to close the suction hole, the generated stress can be mitigated and the durability of the suction valve improves.

Further, according to the present invention, in addition to the above work effect of the invention, the chamfering or rounding mitigates the internal stress generated in the valve seat at the time of forming the concave portion. Therefore, the occurrence of a distortion or the like in the valve plate can be prevented as much as possible.